Finding Missing Baryons in Broad Lyman-α Absorbers

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Introduction

Large-scale structure formation simulations[1] show that at low redshifts, 30-40% of all baryons exist in a low density high temperature plasma (Warm-Hot Intergalactic Medium, WHIM) outside galaxies at low redshifts.
Recent baryon census[2] observes a deficit of 30% baryons at low redshifts even after accounting for 25% baryons in WHIM.
Broad Lyman-α absorption (BLA) from low redshifts can be used to trace the WHIM and account for some of this deficit.
We use HSLA data from HST COS FUV to search for candidate BLAs and model physical characteristics using metal ion absorption from the same system.
To check our methods of automated fitting and modelling physical conditions, we analyse an unreported multi-phase absorber towards PG 0003+158 in detail.

Analysis of the Absorber System towards PG 0003+158

Transition Lines and Components: The absorber system in figure 1 has three components or phases. The zero velocity is set at the redshift of component II, $z = 0.34758$. We fit the Voigt profiles of each transition using a modified version of BayesVP[3], an MCMC algorithm in the Bayesian framework.
Component I is a narrow Ly-α absorber. The maximum temperature this cloud can have is $\mathbf{T = 10^{4.8}}$ **K**. **Component II** is the **BLA candidate** at the central redshift with Doppler parameter $\mathbf{b = 63\ km\ s^{-1}}$. Transitions of OVI ion help us calculate the temperature of this cloud to be $\mathbf{T = 10^{5.39}}$ **K**. **Component III** is a narrow photoionised Ly-α absorber with five metal ion transitions. We perform ionization modelling on this system to predict the physical conditions.
Ionisation Modelling: We use a modified version of the Bayesian MCMC algorithm[4] which uses CLOUDY[5] to predict the number density n_H, metallicity Z and temperature T of the cloud. For component III, we predict these parameters using the column densities from fitting.
For the absorber system at $z \sim 0.347$, we predict the physical conditions in two ways. Omitting OVI column density, we get $\mathbf{n_H = 10^{-2.28} cm^{-3}}$, $\mathbf{Z/Z_\odot = 10^{-0.45}}$ and $\mathbf{T = 10^{4.1} K}$. The OVI column density is not reproduced in this case. We see that including OVI does not give us a good solution that matches the observations. This makes us believe that the OVI arises from another cloud.

Absorber System

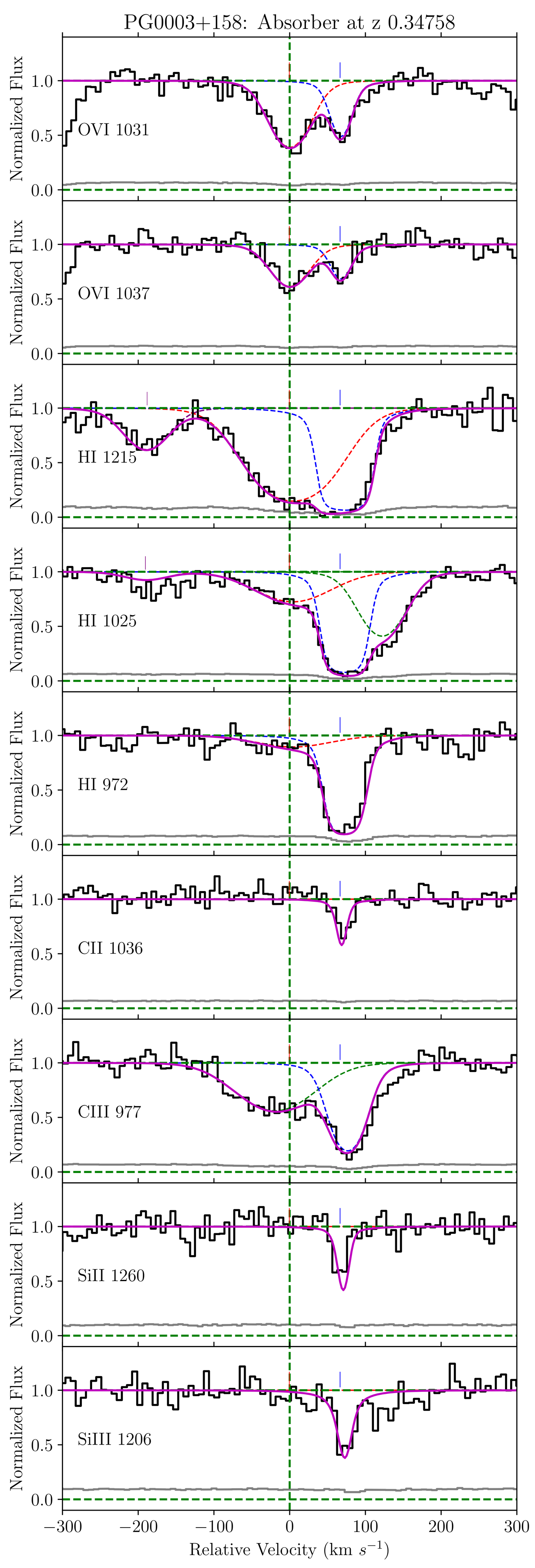

Figure 1: System plot of the multi-phase absorber at z 0.347 towards PG 0003+158. The normalized flux vs velocity relative to the central redshift $z = 0.34758$ for all detected transitions.

Column Density Predictions

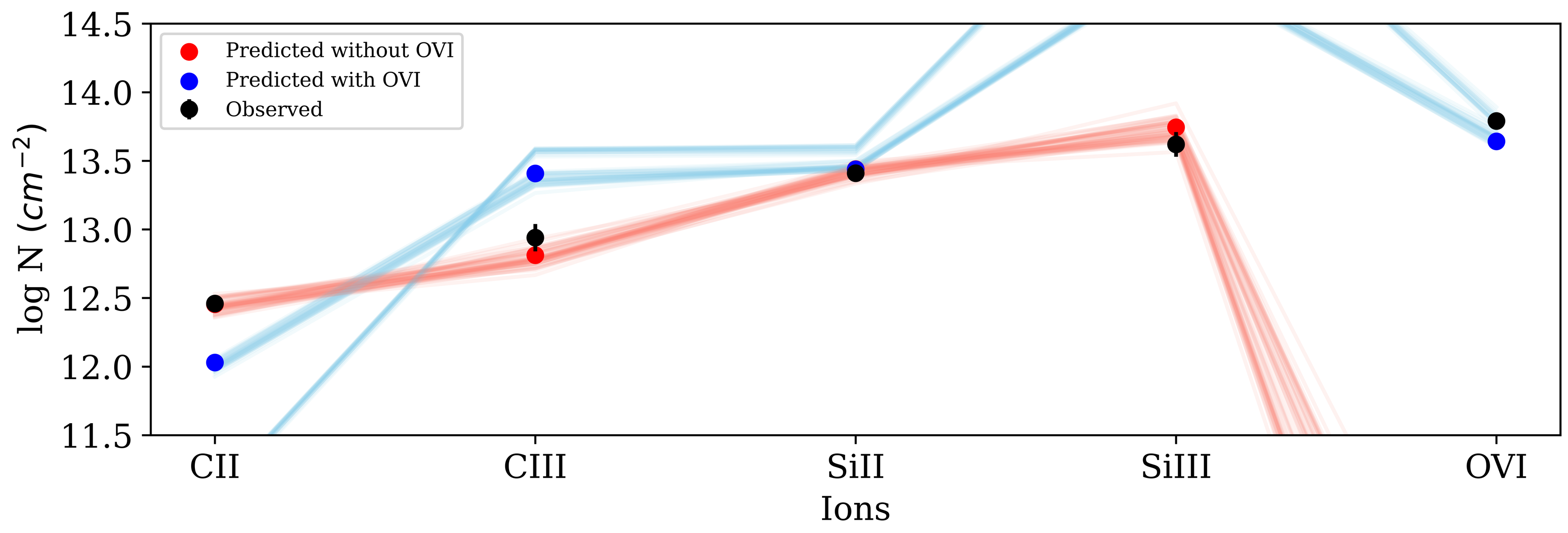

Figure 2: The observed and predicted column densities from ionization modelling with and without OVI column density.

Summary and Ongoing Work

The absorber at $z \sim 0.347$ towards PG 0003+158 may either originate from a very faint galaxy or from a filament in the large-scale structure of the universe.
We continue to search for more BLA candidates to calculate the portion of baryons that can be observed in the BLAs.

References

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[5] GJ Ferland, M Chatzikos, F Guzmán, ML Lykins, PAM Van Hoof, RJR Williams, NP Abel, NR Badnell, FP Keenan, RL Porter, et al. The 2017 release of cloudy. *Revista Mexicana de Astronomia y Astrofisica*, 53(2), 1995,2017.